Critical Review: What are the objective and subjective outcomes of fitting a conventional hearing aid to children with unilateral hearing impairment?

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This critical review examines the objective and subjective outcomes of fitting a conventional hearing aid to children with unilateral hearing loss. Study designs included two single group survey research studies, and one case-series pre-post test. Overall, the evidence failed to show conclusively that children with unilateral hearing loss benefit from wearing a conventional hearing aid, but suggest that their provision should be on an individual basis. Future research with more subjects, more reliable and valid objective measures, and a wider array of hearing losses is needed to develop a treatment protocol.

Introduction

Until recently, it was not believed that a unilateral hearing loss greatly impacted the development of a child. This is because children with unilateral hearing loss can appear to develop normal speech and language and not display any consequences until they begin school. A noisy classroom can pose listening problems for normal hearing children, but for those with unilateral hearing loss these problems are exacerbated and typically manifest as academic or behavioral issues. Outside the classroom, these children are also at a higher risk for having social-emotional and anxiety issues (McKay et al, 2008).

FM systems and preferential seating are often recommended for children with unilateral hearing loss to overcome listening difficulties in classroom situations, but do not address listening needs in all environments. While conventional hearing aids are typically prescribed for bilaterally hearing impaired children, a lot of uncertainty exists around this option for unilateral hearing loss. Audiologists generally question the appropriate age at which to fit a conventional hearing aid and their effectiveness with all degrees of unilateral hearing loss (Tharpe et al, 2008).

In an attempt to determine the objective and subjective benefit that conventional hearing aids may provide children with unilateral hearing loss, three studies were obtained and included in this critical review.

Objectives

The primary objective of this review is to critically evaluate the existing literature regarding the objective and subjective outcomes of fitting a conventional hearing aid to children with unilateral hearing loss.

Methods

Search Strategy

Computerized databases, including Medline, PubMed, Scopus, and Google Scholar were searched using the following search strategy: (children) OR (pediatric) AND (unilateral) OR (mild) OR (minimal) AND (hearing aid) OR (amplification) OR (hearing instrument). The search was limited to articles written in English with humans less than 18 years of age. Once articles were found from the computerized databases, citation searching was performed.

Selection Criteria

Studies selected for inclusion in this critical review paper were required to investigate the effect that fitting a conventional hearing aid had on the auditory abilities, quality of life, and quality of life of the family among children with unilateral hearing loss. No limits were set on the child's current amplification status, outcome measures, or research methods used.

Data Collection

A review of the literature generated the following types of articles in line with the above mentioned

selection criteria: two single group survey research, and one case-series pre-post test.

Results/ Discussion

McKay (2002) conducted survey research with a single group in order to determine whether or not fitting a child with a hearing aid on the impaired ear improved their quality of life. This was determined by fitting children with unilateral hearing loss with a conventional hearing aid and then having parents complete a survey scoring how their child was performing in specific areas with the hearing aid versus how they had done without it. The survey was composed of 12 questions created for the purpose of the study as well as some modified questions from the Children's Home Inventory for Listening Difficulties (CHILD), a 15 item rating scale used to assess, among other things, the benefits of amplification (Anderson & Smaldino, 2000). The surveyed parents and children were also given the opportunity to make further comments about their experiences.

Twenty-eight participants were recruited from the Audiology Department at the Children's Hospital of Philadelphia. Children between the ages of 2 and 17 with mild to moderately- severe hearing loss, useable speech recognition in the impaired ear, and normal hearing in the other ear were fitted with a conventional hearing aid on the impaired ear. Retrospective surveys were completed by the parents of 20 children.

The significant difference wearing a hearing aid versus not wearing one made on a child's quality of life was not determined. However, results of the survey revealed that there were no listening situations in which parents felt that the hearing aid decreased a child's auditory performance or that the hearing aid negatively affected behavior or attention. The only scenarios in which negative responses were reported dealt with frustration and confidence level since receiving the aid, and whether or not the child liked the aid. For these questions, though, the number of negative responses was few compared to the number of "same" or better responses. All of the parents were happy with their decision to have their child fit with a hearing aid and half wished that they had done so sooner. Further, each parent took the opportunity to make additional comments which all indicated that having a hearing aid had been very positive for their child.

Overall, the survey found that fitting a hearing aid to a child with a unilateral hearing loss improved their quality of life (McKay, 2002). Although a decent sample size of 20 was used, there were a number of inherent problems with this study, which included no specifications regarding the developmental trajectories of participants, no statistical analysis of results, and poor presentation of numerical data making it difficult to interpret. In addition, the inclusion of very young children may have negatively affected the results, as children that do not attend school probably do not encounter many challenging listening situations and may not exhibit listening difficulties; for this reason, parents may not have noticed that the hearing aid made a difference (McKay et al., 2008). To improve the validity of the study, the opportunity for parents to make additional comments helped to corroborate the survey results. Unfortunately, the fact that the only assessment was a subjective rating of children's performance by parents means that the validity of the results is dependent upon each parent's response bias for their own child.

This study has a low level of evidence due to the numerous confounds within its design. However, the expression by all parents that they were happy with the results of the hearing aid indicates that this form of treatment should not be ruled out for a child with unilateral hearing loss.

Davis, Reeve, Hind, and Bamford (2001) used survey research to examine the impact of mild and unilateral hearing losses on the quality of life of the children with the impairment and their families. Surveys were sent out to parents to rate their child's ease of listening in quiet and noisy situations with and without hearing aids and also the impact of the hearing loss on the quality of the child's and family's life. The authors hypothesized that the hearing loss would affect the child's and family's quality of life directly and indirectly, such that the survey was composed of questions asking specifically about the child's ability to localize sounds and hear speech in quiet and noise, and

questions concerning the child's educational development and how family activities were affected by the hearing loss. Questions within the survey were developed from previous quality of life questionnaires developed at the Medical Research Council (MRC) Institute of Hearing Research and were used with moderate to profoundly impaired populations.

Surveys were sent out to 150 families of children with mild or unilateral (worse ear >40 dB HL thresholds and a minimum 15 dB HL asymmetry) hearing loss who were seen at the Children's Hearing Assessment Center in Nottingham, UK. A specific age range was not reported for the study, but the average age of the children that participated was 13. Both conductive and sensorineural hearing losses were included as were children with additional disabilities. The number of surveys returned was 63 and 27 were from families with a unilaterally hearing impaired child.

The authors did not specify the type of statistical test performed with the data, but it was found that wearing a hearing aid made a significant difference ($p<.01$) to the ease of listening in quiet and noisy situations. It was also found that 40% of parents with a unilaterally impaired child reported that their child had more problems than they thought was usual pronouncing certain speech sounds and 22% reported that they "often" or "very often" found it hard to understand their child. Despite the potential benefits of amplification, only 26% of unilaterally impaired children wore their hearing aid all the time, 4% only wore it in school, and 50% never wore it. Parents reported the main reasons for not wearing the aid was the associated stigma and bullying. Overall, however, there was little parental concern about communication for unilaterally hearing impaired children. With regards to the impact of a unilateral hearing loss on the quality of life of the family, none of the parents reported that it affected seeing friends and relations, employment opportunities, or income. Although the effect on the family was small, a greater impact was reported by a child's behavior and education than their communication and independence. Finally, a majority of parents did not feel that the unilateral hearing loss had a great impact on their child's life.

The outcome of this study suggests that while a unilateral hearing loss may not greatly impact the child's or family's quality of life, there is still cause for concern and a hearing aid appears to make a positive difference (Reeve et al., 2001). The study was able to include a good sample size which helped to make the results more valid and reliable, and the inclusion of atypically developing children made the sample size more representative of a clinical population. However, the age range of the participants was not included, only an average, making it hard to assess whether or not age affects might have occurred. Additionally, the failure of the authors to disclose exactly how they arrived at the presented significant data and the small amount of statistical data reported makes the validity and reliability of this study difficult to accept.

Therefore, this study appears to indicate that unilateral hearing loss does not greatly affect the quality of life of the child or family and that wearing a hearing aid seems to make a difference in quiet and noisy situations, but its low level of evidence means that the results should be cautiously interpreted.

Updike (1994) conducted case series pre-post research to examine the effectiveness of conventional hearing aids, CROS hearing aids, and FM systems on the word recognition ability of children with unilateral hearing loss in a classroom situation. Each child sat in the center of a regular classroom with two tape recorders on either side presenting speech noise and one tape recorder in front presenting the test stimuli. The listener received a 6 dB signal-to-noise ratio by adjusting volume controls such that 71 dB SPL speech noise and 77 dB SPL speech was heard at the listener's location. Quiet and noisy listening conditions were heard unaided, with a conventional hearing aid, CROS amplification, and FM system, creating a total of eight experimental conditions for each child. Test stimuli consisted of eight revised versions of the Goldman-Fristoe-Woodcock Test of Auditory Discrimination (GFWTAD), which evaluates speech and sound discrimination in the presence and absence of background noise by having children point to one of four pictures representing the stimulus word. The revised versions used the same 25 words from the

GFWTAD quiet test, but in different orders that were randomly selected for each child. The test stimuli were recorded by a female speaker.

Participants consisted of three males and three females between the ages of 5 and 12 years 11 months. Due to the hearing losses of two of the subjects, conventional hearing aids could not be adjusted to meet their needs, so only four were able to take part in the conventional hearing aid condition. All of the children had normal hearing in one ear and normal tympanograms. The unilateral hearing losses consisted of one child with a mild loss, one moderate, one moderately-severe, one severe, and two profound. Each child was fit with a Telex TDR-7 FM auditory trainer with circumaural headphones, and a Telex 334 (CROS) hearing aid. Four children were also fit with a Unitron UM 60 or 60 PP conventional hearing aid depending on the hearing loss.

Individual improvement in word recognition scores was analyzed with the bimodal model of Raffin and Thornton. The child with a mild (37 dB pure tone average) unilateral hearing loss showed a significant improvement ($p<0.01$) in her word recognition in quiet with a conventional hearing aid compared to unaided and in noise she improved, but not significantly. The child with a moderate (42 dB) loss did not experience significant improvement in quiet with a conventional aid compared to unaided, and showed a significant decrease ($p<0.01$) in word recognition in noise with the aid. The child with a moderately-severe loss (63 dB) showed a significant decrease in word recognition ($p<0.01$) in quiet with a conventional hearing aid compared to unaided and a decrease in word recognition in noise, though not significant. Finally, the child with a severe-to-profound loss (85 dB) experienced improved word recognition with a conventional hearing aid in quiet and noise compared to unaided, but the improvements were not significant.

Overall, this study found that fitting a conventional hearing aid to children with a unilateral hearing loss that is worse than mild does not significantly improve speech recognition in quiet and may detrimentally affect speech recognition in noise (Updike, 1994). Controlled test conditions were used to compensate for the small number of participants. The reliability and validity of results were increased as the test environment was a classroom and the signal-to-noise ratio used was thought to closely approximate what would be found in a typical classroom; also, test stimuli were presented via tape recording which removed the bias that would have been present with monitored live voice. It was not mentioned whether or not the children were given time to adapt to the conventional hearing aid before testing, which may have negatively affected results since they were use to listening unaided, but not aided. Further, as only one child with each degree of hearing loss was tested with the conventional aid, it is difficult to generalize the results of this study to other children. The age of the technology in the hearing aids due to the year in which this study was conducted might also have contributed to the negative results found.

While this study appears to indicate that a conventional hearing aid does not improve speech recognition compared to unaided for children with unilateral hearing loss, there is a low level of evidence due particularly to the lack of reproducibility. For this reason, the results should not be fully accepted until additional research is performed.

Conclusion/Recommendations

From this limited body of evidence concerning the objective and subjective outcomes of fitting a hearing aid to children with unilateral hearing loss, it appears that a hearing aid can make a positive difference. Unfortunately, the small number of studies, sample sizes, and objective outcome data on the topic makes it difficult to draw definite conclusions about whether or not a hearing aid will benefit all children with unilateral hearing loss. With the introduction of newborn hearing screening, children with unilateral hearing loss are being identified earlier, which means that intervention programs can be developed and implemented sooner to decease the impact that the hearing loss might have on the quality of life of the child and family. The realization of such programs has been slow because research with this population of children has been challenging due to

the late identification of hearing loss and thus description of their developmental progress (Yoshinaga-Itano et al., 2008). While the challenge of recruiting this population for research is diminishing now that children are being identified sooner, the need for a treatment protocol is growing.

The direction that future research studies should take includes determining the associated effects on development caused by varying degrees of unilateral hearing loss and appropriate intervention programs depending on the degree of hearing loss. Also, future research should address the wider impact that unilateral hearing loss can have on the family life in order for audiologists to be able to counsel families regarding expectations and how to overcome potentially challenging situations. Additional research with objective results showing how well children with unilateral hearing loss perform with and without a hearing aid would greatly assist audiologists in the decision to fit a child with a hearing aid or not.

Clinical Implications

The articles examined in this review have given some insight into the possible benefits a conventional hearing aid may provide children with unilateral hearing loss, but fall very short of being able to state with certainty that each child with this hearing profile should be prescribed a hearing aid. Ultimately, a clinical protocol like the Best Evidence Statement from the Cincinnati Children's Hospital (2009) needs to be developed for audiologists in Canada to use for children with unilateral hearing loss. The Cincinnati protocol specifies that hearing aids should be prescribed in cases of mild to moderate unilateral hearing loss and on a case by case basis for more severe degrees. This protocol further discusses other assistive devices and counseling considerations for families.

While FM systems can make a large impact in the classroom, hearing aids may be the answer for children struggling in other situations. Until a treatment protocol can be implemented, audiologists should base their prescriptions of hearing aids to children with unilateral hearing loss on the degree of hearing loss, individual child and family characteristics, and the needs and desires of the child and family.

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